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Muck and Magic: A Resilience Lens on Organic Conversions as Transformation

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ABSTRACT

Transformation creates space to consider the profound changes necessary for society to pursue just and sustainable social-ecological systems. Transformation involves profound and complex change, yet there are few empirical studies that analyze transformation across multiple spheres of a social-ecological system. This article aims to address this gap by applying a resilience lens to analyze transformation as a component of UK farmers' conversions of farmland from conventional to organic status. Transformation is identified as profound shifts in farmer understanding and management of soil fertility. The analysis finds that these transformations involve interplay between changes and scalar processes across political, practical, and personal spheres of transformation. Changes in the political sphere contradictorily drive, enable, and constrain transformation across political, practical, and personal spheres. We conclude that the empirical resilience analysis of transformation across spheres of a social-ecological system generates insights into the critical processes and changes necessary for society to pursue sustainable futures.

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Agroecology; organic agriculture; participatory resilience assessment; resilience; transformation; United Kingdom

Introduction

Transformation is increasingly promoted in scientific and popular discourse as a solution to many of our planet's profound environmental and social challenges (O'Brien 2012). The growing popularity of transformation stems from concerns over the extent to which society can enable fundamental shifts toward more just and equitable social and ecological outcomes (McAlpine et al. 2015). Resilience theory has recently gained increasing traction as an analytical lens on the complex dynamics of transformation in social-ecological systems (Olsson, Galaz, and Boonstra 2014). Yet, resilience research on transformation in social-ecological systems is characterized by a number of key challenges that limit our ability to gain a reliable understanding of the complex process and outcomes of transformation. These include a tendency by research to conflate the scales at which transformation occurs (Marshall et al. 2012; Brown 2015) and by the relative

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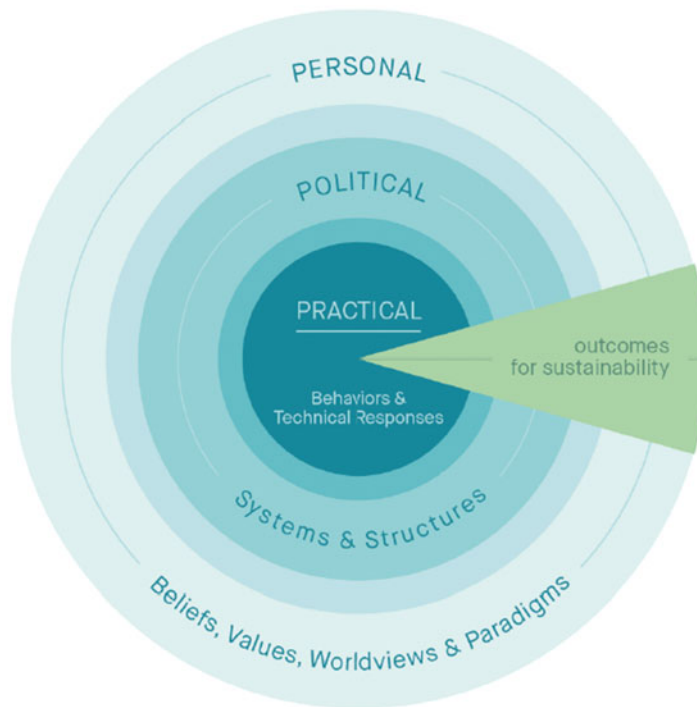


Figure 1. O'Brien and Sygna's (2013) personal, practical, and political spheres of transformation. The practical sphere represents behaviors and interventions; political sphere represents systems and structures that shape change in the practical sphere; and the personal sphere represents the subjective dimensions that influence behaviors and interventions, and how systems and structures are perceived and experienced. Figure reproduced from O'Brien and Sygna (2013).

absence of empirical analysis of the scalar processes that shape transformational change (Park et al. 2012).

Broader social science perspectives on transformation present a number of useful heuristics that enable resilience research to address these gaps. For example, different actors may prioritize transformation at different scales through their preferred “activity spheres” (Pelling, O'Brien, and Matyas 2015). Understanding interactions between such complementary or contradictory priorities for transformation promotes a disaggregated understanding of transformation in social-ecological systems. Additionally, O'Brien and Sygna's (2013) review of climate change literature presents a heuristic of transformation that situates four theoretical approaches to transformation across personal, practical, and political spheres (Figure 1).

These four approaches are represented by transformational adaptation, behavioral transformation, social practices, and social transformations literature. O'Brien and Sygna (2013) emphasized that each of the literature is situated across one or more of the spheres. For example, transformational adaptation literature commonly addresses technological and behavioral change and so focuses predominantly on the practical sphere. Moreover, transformational adaptation literature also recognizes how such changes interact with dimensions of the personal sphere such as identity and the need for wider system change in the political sphere. The second approach, behavioral

transformations literature, focuses on change in the practical sphere. The focus of social practices literature on the influence of social systems and cultural practices on behaviors leads O'Brien and Sygna (2013) to situate the accompanying literature across political and practical spheres. Social transformations literature, the final of the four approaches, much more explicitly addresses change in structures and systems and is thereby situated in the political sphere.

In describing how change in one sphere has implications for change in one or both remaining spheres, resilience research is presented with an exciting opportunity to be increasingly explicit about the scale at which transformation occurs, and how this has implications for and is influenced by, linked social-ecological system changes and scalar processes. Empirical studies of such interactions are, however, largely absent from transformations research (O'Brien and Sygna 2013). In this article, we seek to address these empirical gaps by applying a resilience lens to analyze whether UK farmers' understanding and practice transforms as a component of UK conversion of farmland from conventional to organic status.¹ We also aim to analyze how such transformation relates to broader agricultural and social-ecological system changes and scalar processes. We then apply insights from the resilience analysis to O'Brien and Sygna's (2013) spheres of transformation to elaborate new insights on transformation in social-ecological systems.

Agricultural systems form the focus of this empirical analysis due to the extensive social and environmental crises that mean transformation toward more sustainable practices offers the only viable sustainable solution (Gliessman 2014a, 2014b). Consequently, this research is interested in understanding why UK farmers decide to convert farmland to organic status and the systemic changes that shape their decisions to do so. Such decisions are commonly framed as economically driven, for example, the opportunity for a price premium on organic produce; as affected by an increased desire to act as stewards of land through an organic philosophy; and to address UK farmers' dissatisfaction with their conventional systems (Lamine and Bellon 2009). However, despite growing literature analyzing conversions of farmland to organic status across the European Union, Lamine and Bellon (2009) highlighted that the multi-dimensional issue of farmer decision-making during conversions of farmland to organic status has received very limited scholarly attention. Our review of literature suggests that this remains the case, particularly, in UK contexts where we are unable to identify any literature analyzing UK farmer decision-making during conversions to organic livestock systems.

Resilience is understood here as the ability of actors and systems to increase their capacity to address change effectively. A resilience perspective characterizes transformation as the outcome of a profound shift in state, function, form, or location from one to another (Brown 2014), and a process that involves preparing a system for change, seizing windows of opportunity, and building the resilience of a new desired system state (Olsson et al. 2006). Actively promoting these shifts requires capacities for innovation and creativity, learning, leadership, and self-organization (Folke et al. 2005). The panarchy heuristic helps resilience scholars to explain transformation by demonstrating how larger, top-down processes interact with smaller, bottom-up processes (Holling and Gunderson 2002). Yet, insights derived from panarchy are limited by the tool's overarching focus on the implications of change at a broader systems scale, and the abstract

and metaphorical nature of panarchy mean that its empirical applications remain largely limited (Allen et al. 2014).

This research applies a suite of resilience concepts to analyze transformation as a component of conversions of farmland from conventional to organic status by livestock farmers in Cornwall and Devon, United Kingdom. The article proceeds by describing how the three-phase approach to participatory resilience assessment operationalizes resilience and transformation in the context of conversions of UK farmland from conventional to organic status. Empirical results are presented as analytical themes and used as the foundation for a discussion that generates novel insights into interactions within, across, and among O'Brien and Sygna's (2013) political, personal, and practical spheres of transformation.

Participatory Resilience Assessment

Resilience assessments operationalize resilience concepts in a way that encourages alternative perspectives and practices toward natural resource management contexts (Resilience Alliance 2010). Participatory approaches to resilience assessment, such as the techniques employed in this research, help to elucidate participants' subjective experiences of transformation across scales (Bergold and Thomas 2012) and address resilience in ways that have relevance and meaning for participants (Sellberg et al. 2017).

Defining a focal-social-ecological system is a well-known challenge in social-ecological systems research (Sinclair et al. 2017). For example, system boundaries are perceived contrastingly by different actors, and social networks commonly extend beyond the confines of system boundaries (Enfors 2013). To address this challenge, we applied Enfors' (2013) criteria for delimiting a social-ecological system by the location of core actors, resources, and their interconnections. Accordingly, this research focuses on Livestock Farming Discussion Group² (LFDG) members' understanding of how their farms, and especially the relationship among the livestock-grazing-soil interactions, interact with the farming systems that surround their farms within the Tamar river catchment, United Kingdom, and their external social-ecological systems.

The research was performed with the single case study LFDG, based in the Tamar river catchment, United Kingdom, during 2012–2016. A single case study approach enables analysis of rich qualitative and context-specific data (Yin 2009). LFDG was identified through key informant interviews with agricultural actors in Cornwall, United Kingdom. The selection criteria for the case included identifying a group that had been established for a substantial period of time and that continues to operate. We also sought a group that included farmers who had experienced significant change on their farms. LFDG identified as the only group that met these criteria and, after agreeing to engage in the research, became the case study analyzed in this article. The significant process of change identified by the group is the conversion of farmland from conventional to organic status. LFDG's current membership comprises of 15 males and one female. Thirteen male members (11 beef farmers and two dairy farmers) participated in the research. All participating members had converted their farmland from conventional to organic status.

The first phase of the participatory resilience assessment involved narrative interviews, guided by participatory timelines, with 11 out of LFDG's 16 members. A narrative approach provides insight into participants' lived experiences of transformation (Hards 2012) and accesses tacit experiences of social learning and experimentation that build capacity for transformation (Roth and Kleiner 1998). The interviews enabled us to analyze components of conversions of farmland from conventional to organic status for transformation in farmer understanding and practice and to explain how these transformations relate to key social-ecological system scalar processes. We did this by asking participants to co-construct timelines of the most significant moments in their conversions of farmland to organic status. We used the timelines to prompt participant reflection on each significant moment by asking what happened, why it happened, and who was involved. Interviews were digitally recorded and transcribed verbatim. Analysis of narrative interviews is outlined in parallel with participatory scenario planning later in this section.

The second phase of data collection involved semi-structured qualitative mental models interviews with 12 of the 13 individuals who participated in narrative interviews. A mental models approach provides this study with a means of understanding the cognitive structures that underpin participants' decision-making and behavior, and so help us to understand how participants might interact with their perceived worlds (Jones et al. 2011). We, therefore, used the approach to analyze how participants' on-farm decision-making interacted with perceived feedback loops and thresholds in their external social-ecological systems. All 12 interviews were conducted in participants' homes. Five participants concluded their interviews with a guided farm walk during which they elaborated additional interactions between their farms and their external social-ecological systems. Only one participant chose to represent their mental model diagrammatically. However, the diagram was omitted from analysis as, rather than presenting how an organic grazing system interacts with its external social-ecological system, it instead depicted how traditional paddock grazing differs from mob grazing. The diagram was not entirely redundant though as it acted as a prompt for the participant to orally elicit his mental model of interactions between his grazing system and the external social-ecological system. The oral transcript from this interview was, therefore, included in analysis.

Feedback loops were analyzed by using an adaptation of Jones' (2012) approach to content analysis in which the researcher constructs mental models as a system of

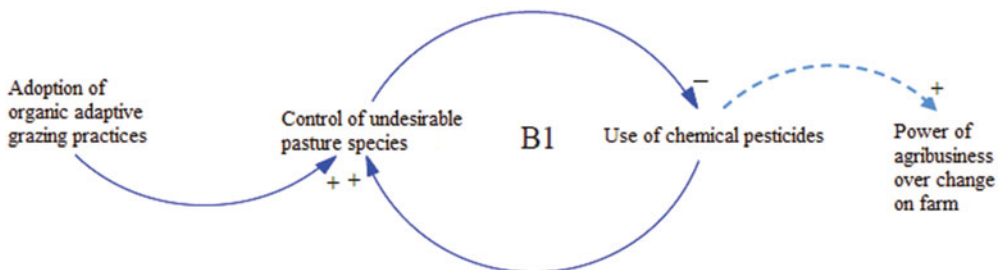


Figure 2. Example feedback loop extracted from causal link diagram of participant's mental model. The balancing feedback loop (B1) illustrates the perceived effects that adaptive organic grazing practices have on the control of agribusiness over the participant's management of their livestock system. The dotted line represents the participant's implicit thinking.

concepts and functional linkages. Using Vensim software, the researcher then constructs casual loop diagrams from interacting concepts and functional linkages (Figure 2) and interpretation of participants' implicit thinking during mental models interviews. Where present, feedback loops were then identified in the causal link diagrams. Thresholds were operationalized by asking participants what critical things can cause change in the way their organic grazing systems function, and what would cause them to significantly change their system.

The final phase of research used a participatory scenario planning workshop similar to Evans et al. (2006), in which participants elaborated future-oriented perspectives on transformation. Nine members of LFDG, all of whom participated in narrative and mental models interviews, participated in the participatory scenario planning workshop. The workshop began with participants identifying and ranking uncertain and important scalar processes that were expected to drive change on their farms in 15–20 years' time. The saliency of this timescale emerged from preceding reflective and mental models interviews, during which participants expressed concerns over retirement and intergenerational succession on their farms. The two most uncertain and important scalar processes were plotted on axes that charted their development over a better-worse continuum. The two axes were then plotted against each other to create a matrix containing four different scenarios. Participants split into three groups of three people, and each group selected one matrix plot as the foundation for their scenario.

Participants were then asked to develop plausible scenarios guided by a set of questions that addressed resilience concepts relevant to transformation including capacity, feedbacks, and thresholds. Participants shared their scenarios with the group and voted for what they believed to be the most likely and most desirable scenarios. We then facilitated a deliberative discussion about how participants understood their individual and collective capacities to make the most desirable scenario become the most likely scenario. This latter aspect of the workshop was particularly important as it encouraged participants to uncover and address assumptions, and cognitive biases that shape their capacities to address change in their external social-ecological systems (Wollenberg, Edmunds, and Buck 2000; Oteros-Rozas et al. 2015).

Narrative interview and participatory scenario planning workshop transcripts were analyzed using Braun and Clarke's (2006) six-phase approach to interpretive analysis. The inductive and iterative analytical process used open-coding to construct key themes that distinguished whether transformation occurred; how transformation was represented; the key scalar processes relating to transformation; and the specific scales at and across which these changes occurred. Emergent findings from all three research techniques were triangulated to ensure rigor in the findings presented by this study.

Results

The results of this analysis are organized as analytical themes that articulate how LFDG members' transformations in understanding and management of soil fertility occur as a component of the conversions of their farmland from conventional to organic status. The themes describe how LFDG members' transformations in understanding and

management of soil fertility relate to key scalar processes and changes that occur at and across farm, regional, national, and international scales.

Transformations in Understanding and Management of Soil Fertility

LFDG members' conversions of farmland from conventional to organic status involved reciprocal transformations in their understanding and management of soil fertility. Transformation was operationalized by analyzing narrative interviews for signals of profound change in participants' perceived abilities to manage change on their farms. Nine out of eleven participants' narrative interviews articulated that transformational change occurred in their understanding and management of soil fertility, in a way that provided them with a much greater sense of agency over their grazing systems. These findings were triangulated against mental models interview data, the outcome of which identified clear evidence of transformations in understanding and management of soil fertility in all participants' transcripts. Transformations in the understanding of soil fertility are evidenced by shifts from chemical to biological conceptualizations of soil fertility.

This was a whole new system of learning why the ground acts like it does when it's organic, and what you have to do to get the ground to work. Things like aeration of the soil and looking after the biology in the soil were just new to me. Everything the soil needed you put on. That was the old, the old conventional way of doing things. But now, and especially in those first two or three years, you think if this doesn't work, if I have go back to conventional farming, I would go back completely different because of what we learned after 2009. [David]

So actually the only thing that you can do is to do something differently or, effectively, to use that awful word, to have a shift in your paradigm, you know, in your thinking. And actually sort of make your own rule. It's so different to what you're doing you're off on a completely different trajectory. [Charlie]

I think the whole thing about going organic is you've got to convert yourself before you convert your farm. You've got to get your head thinking differently. [Dan]

Participants' transformations in the management of soil fertility are characterized by shifts away from practices that relied on external flows of artificial resources such as chemical fertilizers and pesticides, to interventions and practices such as herbal leys, adaptive grazing systems, and bio-fertilizers that were perceived to harness internal flows of resources to participants' farms.

... if I can create more soil I've got more nutrients. I can have more water retention. I can draw more minerals from deeper down. It just goes on doesn't it? It's a big thing thinking you can create more soil. [Adam]

Actually what you're trying to do is catalyse natural processes and make them work. So you're orchestrating a natural system that works rather than orchestrating an artificial system. [Charlie]

Participants' transformations in the management of soil fertility also manifest as shifts away from practices that threatened the biological fertility-building processes understood as beneficial to organic farming. For example, herbal leys were sown to replace

Table 1. Changes influencing participant decisions to convert UK farmland from conventional to organic status.

Speed of change	Type and characteristics of change	Experience of change
Abrupt	Volatility of global market dynamics for prices paid for agrichemical inputs and prices offered for farm produce.	Sense of helplessness to manage change effectively on farm.
	Animal disease events, including BSE and foot and mouth.	Stress and despair. Experienced unequally—winners and losers.
	Personal loss and bereavement.	Shock and grief. Unexpected responsibility.
	Anticipated regulation under EU Nitrates Directive.	Fear that decision making related to conventional farming would become further constrained.
Slow	Yield maximizing approach to conventional farming.	Persistent anxiety and stress.
	Privatization of agricultural knowledge and advisory services.	Feelings of unwanted dependence on advice tied to commercial interests of agribusiness organizations.
	Intergenerational succession	Reduced wellbeing through lack of opportunity to spend time with family.

the routine use of plowing. The deep rooting nature of herbal leys replaced the mechanical soil disruption of plowing, reduced loss of soil carbon, and reduced compaction in deeper layers of soil.

Preconditions for Decisions to Convert UK Farmland from Conventional to Organic Status

Preconditions for participants' decisions to convert UK farmland from conventional to organic status are characterized by a complex set of slow and fast changes at occurring away from their farms (Table 1). These changes created an intensification trap that participants sought to escape.

Participants experienced these changes differently and unequally. The 2001 UK wide outbreak of foot and mouth disease exemplifies this differentiation. Participants, whose herds were infected and culled, received financial compensation from the government for their losses. However, participants, whose herds were not infected, emphasized the crushing nature of the experience as farm enterprises became compromised by restrictions on the movement and sale of livestock, and a parallel crash in prices offered for their produce.

Participants' decisions to convert farmland from conventional to organic status were also influenced by changes that impacted on their wellbeing. For example, participants with dairy grazing systems emphasized that a drive for yield maximization in UK agricultural knowledge systems and systems of agricultural land management created feelings of being in a constant race "*chasing milk*." Participants responded by farming more intensively on their current acreage, renting or buying new land to increase the volume of their production, or investing heavily in new infrastructure that could accelerate processes of production. In many instances, the latter two options resulted in obtaining bank loans that increased already high debt levels charged against their farms. The pressure to intensify production at the scale of the farm led to increased herd health issues, and wellbeing challenges for participants characterized by stress, anxiety, and powerlessness to effect change. Another participant reflected on how a sudden bereavement caused him to reconsider whether he wished to continue with the pressures of his conventional farming system. Conforming to the yield maximizing approach in UK systems

of agricultural knowledge and land management ran counter to these desires for wellbeing.

Windows of opportunity played an instrumental role in enabling participants to fortuitously escape the constraints of their conventional systems and convert their farmland to organic status. In this case, participants articulated that the availability of UK organic conversion subsidies during 2008–2010 presented a window of opportunity for them to shift away from their conventional systems. UK organic conversion subsidies, made available by the EU Common Agricultural Policy, provided financial compensation for anticipated reductions in financial turnover caused by limitations on production and drops in soil fertility whilst conventionally farmed land was converted to organic status (Defra 2014). Subsidies were paid for 2 years, for every acre of land placed into organic conversion. Once the 2-year conversion period was complete, individuals received an ongoing payment per acre of land in organic production through the organic entry level stewardship scheme. Participants explained that the availability of the subsidies during their times of need fortuitously enabled them to escape the constraints of their conventional systems.

The experiences of several participants emphasize that decisions to convert farmland to organic status were part of a complex process in which organic farming competed against other viable alternatives. One participant experienced such financial difficulties that he decided to exit farming altogether. Conversely, another participant no longer wished to pursue a future in farming, but he was unable to sell the farm as he lacked the agreement family members who were co-owners of the farm. Viewed as a sum, these insights highlight the strikingly non-linear, and at times fortuitous processes and outcomes that led to participants converting their farmland from conventional to organic status, and pursuing their subsequent transformations in understanding and management of soil fertility.

Key Individuals and International Agroecological Shadow Networks

Social learning, enabled by the membership of LFDG and enacted across farm to international scales, was instrumental to participants' transformations in understanding and management of soil fertility.

... this is where a discussion group comes in, is seeking the help of other members of the discussion group saying what should you do? What advice have they got? Have they encountered that same problem themselves? If they did, how did they overcome it or not? So that's, you know, where your discussion group is so important. It's another feedback loop. [Charlie]

Mavericks, defined as individuals who contribute radically alternative understandings and practices for managing soil fertility, played significant roles in these processes of learning (Table 2).

Mavericks catalyzed transformations in the understanding of soil fertility by introducing counter-intuitive practices that challenged participants' chemical understanding of soil fertility.

...and then he just like opened-up a world I'd never even seen, of ways you can do things completely differently. [Jack]

Table 2. Key individual roles and characteristics in shaping capacity for transformation in UK farmer understanding and management of soil fertility.

Role	Characteristics of role
Facilitator	<ul style="list-style-type: none">• Link learning to current challenges.• Build confidence to experiment with novel practices through experiential learning and mutual support outside of learning events.• Create unified vision for learning.
Maverick	<ul style="list-style-type: none">• Act as boundary spanners to cross-scale networks of maverick key individuals.• Perceived by followers as thought leaders.• Seek and test radical ideas and practices in their localities.• Challenge mainstream assumptions, norms, and practices.• Inspire and motivate learning through passion and enthusiasm for topic.• Demonstrate efficacy of novel practices at local and international scales.

LFDG’s membership included five mavericks who nurtured the group’s broader membership’s capacity to experiment with alternative approaches to managing soil fertility on their farms.

... you need a core of likeminded individuals who are thinking outside the box, you know, mentally agile. They have a lot of experience they can draw from and they’re not completely highbrow in how they apply those experiences. [Charlie]

Participants’ capacity to sustain the rapid learning that facilitated their transformations in understanding and management of soil fertility became constrained by a limited pool of potential new mavericks within close proximity to their farms.

Well, learning is the problem. You know, people aren’t about [not present]. We’ve been struggling all the way through to find people with more knowledge than we’ve got now. It’s been difficult. [Dan]

Participants addressed this limitation by pursuing interactions with mavericks operating in agroecological knowledge shadow networks across regional to international scales. In this study, agroecological shadow networks are un-official networks that consist of mavericks, activists, scientists, and non-governmental organizations. The networks create and advance radical agroecological alternatives that counter mainstream approaches to managing soil fertility. Regional and national actors in shadow networks, originating in the United Kingdom, such as the Nuffield Farming Scholarships Trust (<http://www.nuffieldscholar.org/>) and RegenAg UK (<http://www.regenerativeagriculture.co.uk/>) linked participants to networks of international actors based in New Zealand, Australia, Ireland, and United States. By collaborating within and across the shadow networks, participants were able to experiment with novel ways of understanding and managing soil fertility that were not readily accessible within the agricultural knowledge and land management systems surrounding LFDG’s members’ farms.

Shifts in Capacities to Address Change beyond the Farm

A key analytical gap exists in examining the extent to which transformations in understanding and management of soil fertility changed their capacities to address change in their external social-ecological systems. Our analysis highlights participants’ profound sense of confidence in their abilities to insulate themselves from the effects of shocks and incremental changes that characterized their conventional grazing systems. For

example, participants suggested that their transformations in understanding and management of soil fertility enabled them to reduce their likelihood of their farms being impacted by animal disease events, such as BSE and foot and mouth. Furthermore, participants emphasized that by perceiving soil fertility as a biological process, they could significantly reduce their reliance on external organic fertility building inputs.

Nevertheless, change beyond participants' farms was seen to be highly volatile and uncertain. Climate change, the power of global agribusiness corporations over agricultural knowledge and land management systems, and the EU Common Agricultural Policy were identified as key drivers of volatile system dynamics that impacted on change on their farms. Volatility was not considered constant or fixed to specific changes; one participant emphasized that a reduction in volatility in one component of the external system could result in an increase in volatility in another component. Yet, participants were distinctly optimistic that their transformations in understanding and management of soil fertility enabled them to concurrently address and derive benefits from the uncertain landscape of change beyond their farms.

Throughout our engagements with LDFG participants emphasized that their transformations in understanding and management of soil fertility enabled them to sequester atmospheric carbon in their farmland, thereby minimizing their contribution to climate change, and additionally improved downstream water quality for the Tamar river catchment. Participants' confident outlooks were further reflected in the buoyant naming of scenarios as "Carbon bulldog," "Rose tinted illusionists," and "Future's good." The "Carbon bulldog" scenario constructed a future in which participants' transformations in understanding and management of soil fertility ensured they could easily adapt to any shocks caused by anticipated changes to soil carbon regulations in UK implementation of the EU Common Agricultural Policy.

...because we're aware of increasing soil carbon we'll probably be seen to be leaders rather than followers. It'll probably become the norm rather than being seen to be eccentric. Not being idiots in the village anymore. [Brian]

These reflections suggest that participants were confident their transformations in understanding and management of soil fertility, and the conversions of farmland to organic status within which these transformations were embedded, were becoming increasingly accepted by their conventional peers. Participants felt that they could enhance opportunities for acceptance by leading and participating in processes of social learning that extended beyond the limitations of membership of LDFG. For example, one participant hosted a soil carbon symposium attended by conventional and organic farmers from the Tamar river catchment and surrounding region. Another participant hosted a learning event on the benefits of mycorrhizal fungi to soil fertility. These processes of social learning provided participants with opportunities to encourage their conventional peers to overcome their perceptions of organic farming as a process involving only "*muck and magic*."

A lot of people think organic farming is all muck and magic. But you've got to farm, seriously farm it. I think if you don't study it and work at it, it's going to be an utter disaster. [Dan]

Some participants felt that, however contextualized, their transformations in understanding and management of soil fertility contributed to a greater sense of transition in broader systems of agricultural production.

....put a domino against a slightly bigger domino, against a bigger tower block and the little domino can make the tower block fall over. It's just a sequence of events. Little acorns grow big trees, big oak trees. [Brian]

Conversely, other participants believed that although they could contribute to changes in agricultural knowledge systems within the Tamar river catchment, their capacity to directly change the set of national scale processes that constrained conventional agriculture was distinctly limited.

...we can't change the way that farming is going; the majority. But we can try and educate them. That's the only thing I would say, but we're not going to change it. [Toby]

These scalar processes were identified as a pervasive yield maximizing approach to agricultural land management, rigid and non-participatory UK implementation of the EU Common Agricultural Policy, and the power of global agribusiness corporations over agricultural knowledge and land management systems. For example, participants expressed frustration at what they perceived to be limited opportunities for participation in processes of agricultural policy development such as consultations for the UK implementation of the Common Agricultural Policy. By increasing participation, participants felt that would have a greater opportunity to contribute to significant shifts in agricultural land management across regional to national scales.

Discussion

This study identifies transformation as profound shifts in understanding and management of soil fertility by livestock farmers in Devon and Cornwall, United Kingdom. The resilience lens applied to this study elaborates how the identified transformations interact with key scalar processes such as agricultural knowledge and land management systems. These scalar processes are inherent to O'Brien and Sygna's (2013) spheres of transformation and, in particular, those of the political sphere. Specifically, our empirical insights highlight how a contradictory set of changes in the political sphere drive, enable, and constrain interplay across political, practical, and personal spheres of transformation (Figure 3).

This research finds that the preconditions (see 1, Figure 3) for transformation across personal and practical spheres are created by the effects of abrupt and slow changes in key scalar processes including a yield maximizing approach to agricultural knowledge and land management systems, volatile global market dynamics of agrichemical inputs, and national animal disease events. These changes interact with experiences of bereavement, and concerns toward the constraints of intergenerational succession, to create a set of adverse emotional states characterized by participants' fear, anxiety, and despair toward their capacities to pursue tenable futures in conventional farming. A resilience interpretation of the effects of these changes suggests that participants operate within rigidity traps at the scale of the farm (Carpenter and Brock 2008), whereby changes in the political sphere reduce farm resilience by constraining the resources available to

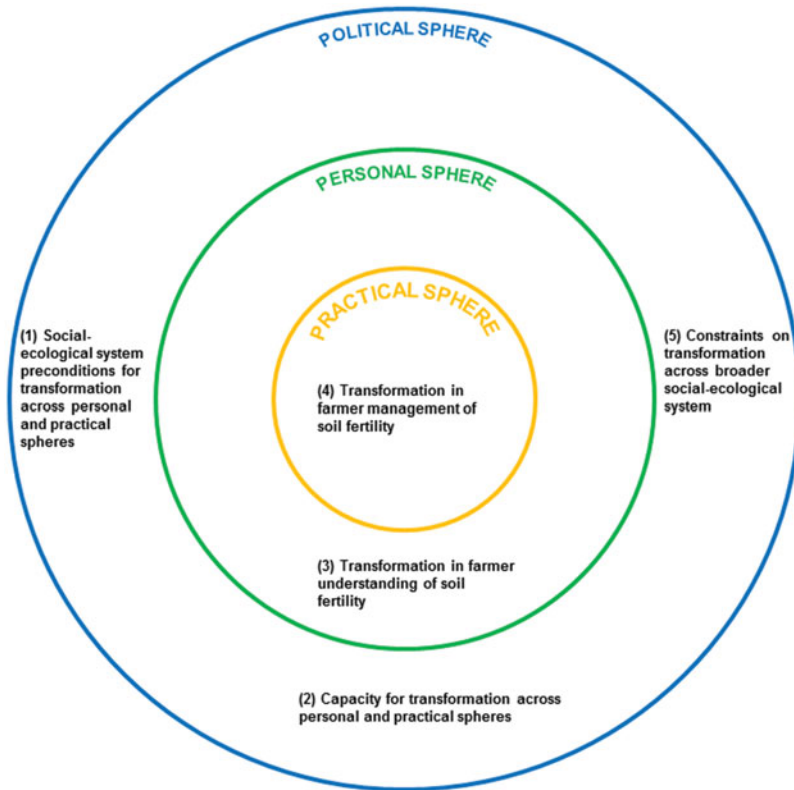


Figure 3. Interplay among O'Brien and Sygna's (2013) personal, practical, and political spheres of transformation. System changes in political sphere of transformation contradictorily drive, enable, and constrain change across personal, practical, and political spheres of societal transformation. We situate personal and practical spheres within the political sphere to represent how participants articulated their transformations in understanding and management, across personal and practical spheres respectively, interact with changes across the political sphere.

participants to pursue their desires for wellbeing and enact the profound change across personal and practical spheres of transformation.

The contradictory nature of change in the political sphere is exemplified by the pivotal role of windows of opportunity (Olsson et al. 2006) that shape the preconditions necessary for fundamental change in personal and practical spheres of transformation. A window of opportunity in the political sphere, in this case, organic conversion subsidies enabled by UK implementation of the EU Common Agricultural Policy, fortuitously provides participants with the enabling conditions to break their rigidity traps. The financial security provided by the subsidies provides participants with opportunity to make the uncertain leaps required to break their traps. These findings highlight the messy and non-linear nature of change that follows from participants acting on windows of opportunity in the political sphere of transformation. As discussed, transformations in understanding and management of soil fertility are catalyzed by capacity building processes of self-organization and social learning involving distinct contributions from maverick and facilitator key individuals across international scales (see 2, Figure 3). Without the dynamic combination of these fortuitous and deliberate

individual actions, it is very possible that participants may not have achieved the transformations in understanding and management of soil fertility (see 3, [Figure 3](#)) that enabled them to increase the resilience of their farms or, even still, have ultimately returned to the rigidity traps that constrained their preceding conventional systems.

We have articulated how the political sphere contradictorily drives, enables, and constrains the intertwined transformations in understanding and management that bridge personal and practical spheres of transformation. Returning to insights offered by the panarchy heuristic (Holling and Gunderson 2002), this research demonstrates how larger, slower changes in the political sphere shape opportunities for smaller, bottom-up changes in the personal and practical spheres of transformation. Conversely, panarchy directs us to consider how processes of revolt including experimentation, novelty, and learning at smaller scales influence change in the slower, larger scales that stabilize change in a social-ecological system (Holling, Gunderson, and Peterson 2002). The heuristic, therefore, prompts us to consider whether participants' transformations in understanding and management of soil fertility that span personal and practical spheres of transformation can be scaled-out to profoundly reconfigure enduring systems of agricultural knowledge and land management in the political sphere of transformation.

Insights from this analysis demonstrate that participants believed their actions contributed to a much greater process of change taking place in agricultural systems beyond their farms. Participants' perceived capacities to nurture transformations in understanding and management of soil fertility among their conventional peers in the farms surrounding LFDG members suggest that opportunities exist for broader significant change in personal and practical spheres of transformation. However, we see strikingly limited signals of transformations in personal and practical spheres being scaled-out to effect transformation in the political sphere of agricultural production at national and international scales (see 5, [Figure 3](#)). In particular, this research illustrates how the perceived power of global agribusiness corporations and pervasive yield maximizing approach inherent to systems of agricultural knowledge and land management across international scales, and limited opportunities for farmers to participate in shaping the UK implementation of the EU Common Agricultural Policy in a way that reward agroecological practices, limit opportunities for participants' transformations to be scaled-out. Broadening participation through processes of adaptive governance would address the latter concerns by enabling individuals to contribute to voluntary processes of self-organization that link networks and actors across multiple scales and levels (Olsson et al. 2006). Yet, these important and meaningful processes of governance do not currently feature in the UK implementation of the EU Common Agricultural Policy. These empirical insights highlight the inherent challenges of navigating persistent uncertainties in the political sphere of transformation, whilst simultaneously creating opportunities to ensure that profound change in the personal and practical spheres of transformation can be sustained into the long term.

Conclusion

Transformation is increasingly promoted as a necessary component of sustainability in agro-food systems. This article applies a resilience lens to generate new empirical insights into the dynamics of transformation in social-ecological systems. Viewed as a

sum, the findings presented in this study inform our conceptual understanding of transformational processes and their dynamic interplay. The novel participatory resilience assessment presented here highlights the subjective, lived experienced transformation in terms and research environments that are relevant and sensitive to participants' experiences. These insights elaborate an understanding of transformation as an emotional and messy process of change, comprising of multiple, and interrelated changes across local to international scales.

We identify reciprocal transformations across personal and practical spheres that manifest as intertwined transformations in understanding and management of soil fertility. In setting boundaries around what we represent as transformation, we have articulated interplay among personal, practical, and political spheres within which transformation is enmeshed. We have highlighted how change at regional and international scales contradictorily drives, enables, and constrains transformation at individual, farm, and broader societal scales. Our analysis sheds light on the enduring structures of the political sphere that constrain the capacity for transformations in personal and practical spheres to be scaled-out to effect broader transformational change in agricultural systems of production.

Yet, despite the identified constraints, a new window of opportunity for transformation in the political sphere of agricultural systems of production may emerge as negotiations for the post-Brexit agricultural regime become a reality. Beyond any anticipated transition period, the potential removal of Common Agricultural Policy subsidies creates the opportunity to move toward new forms of governance with the potential to profoundly change the mechanisms that distribute and value agricultural land and to incentivize land management practices that provide goods through ecosystem services principles. Insights such as those provided by this study, across these multiple dimensions and spheres of transformation, are necessary to guide society toward more sustainable futures.

Notes

1. Organic farming in the UK involves managing soil fertility through practices that avoid the use of chemical fertilisers and pesticides. Minimum standards for organic farming are set by the European Union. Converting land to organic status commonly takes two years. Land can be certified as organic by one the UK's nine organic control bodies. Food produced through organically certified schemes can then be marketed for consumption as an organic product (Defra 2017)
2. The names of the group and its members have been anonymised to protect their privacy and identities.

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